



Radioactivity - Radionuclides - Radiation

8th Multi-Media Training Course with Nuclides.net

Thursday, 14th September 2006

Case Study: Nuclear Medicine

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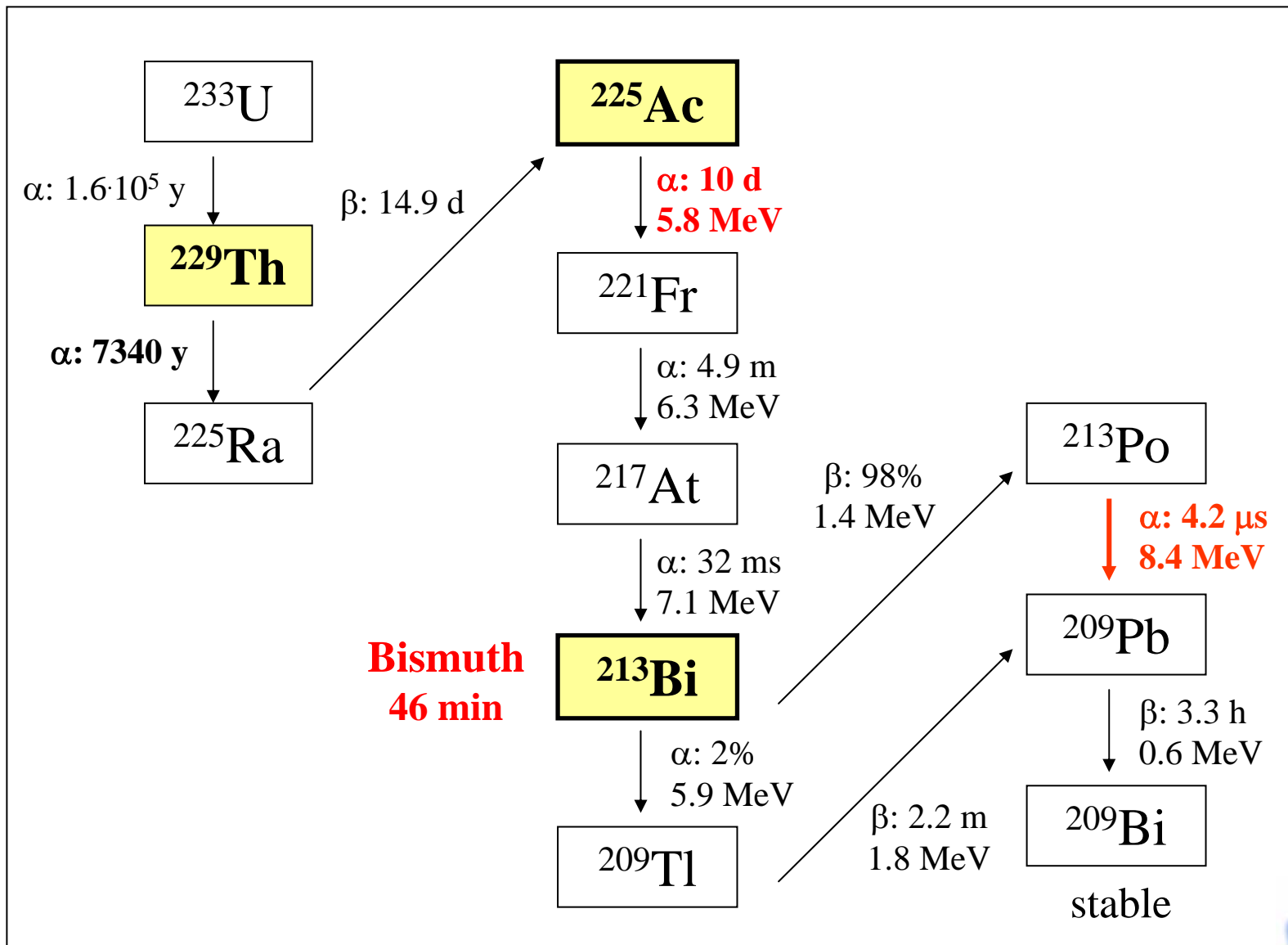


Overview:

- 1st case: Th-229/Ac-225
- 2nd case: Ra-225/Ac-225
- 3rd case: Elution yields of Ac-225/Bi-213 generator
- 4th case: decay of Bi-213 and the decay products

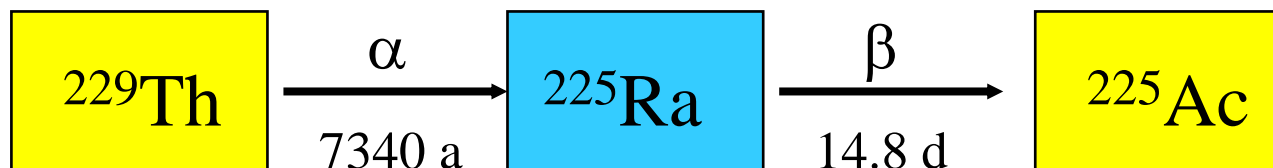


The Ac-225/Bi-213 system





1st case:
increase of Ac-225 from Th-229

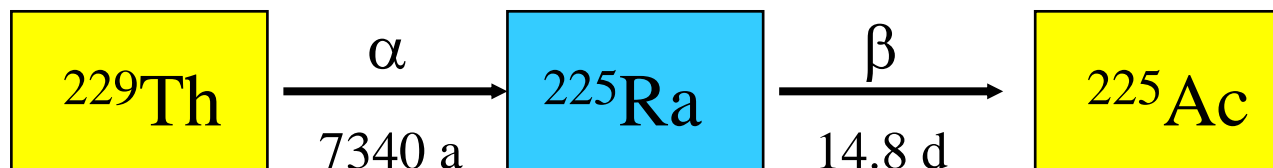


- ITU's Th-229 source: 45.6 mCi

? Activity of Ra-225 and Ac-225 6, 9 and 12 weeks after previous separation
? Graphical plot



1st case:
increase of Ac-225 from Th-229



- ITU's Th-229 source: 45.6 mCi

? Activity of Ra-225 and Ac-225 6, 9 and 12 weeks after previous separation

week	$A_{\text{Th-229}}$	$A_{\text{Ra-225}}$	$A_{\text{Ac-225}}$
6	45.6 mCi	39.1 mCi	31.0 mCi
9	45.6 mCi	43.2 mCi	39.4 mCi
12	45.6 mCi	44.7 mCi	43.1 mCi



- choose the nuclide Th-229 and open nuclides.net, decay-button
- enter the activity and time

nuclides.net **229 Th** Full Decay

Options

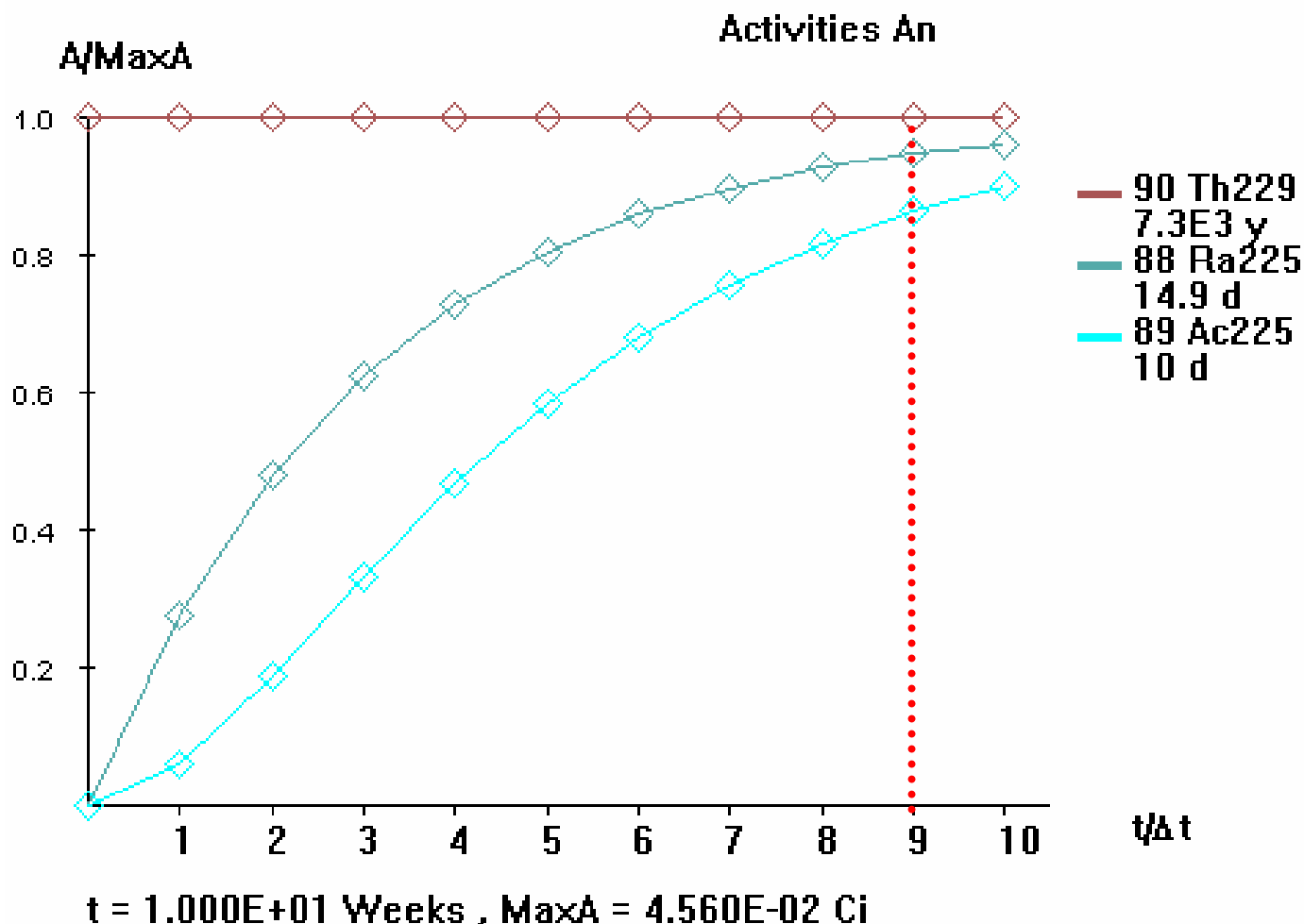
Quantity: Distance(cm): Min. Prod.:

Time: Number of time steps: N° Chains:

Parent+Daughters	Half-life	N(atoms)	M(g)	A(Ci)	G(keV/s)
90 Th229	7.3E3 y	5.6378E+20	2.1442E-01	4.5597E-02	5.8057E+10
88 Ra225	14.9 d	3.0704E+15	1.1473E-06	4.4681E-02	1.9838E+10
89 Ac225	10 d	1.9872E+15	7.4254E-07	4.3088E-02	1.7729E+10
87 Fr223	4.9 m	6.7619E+11	2.4816E-10	4.3088E-02	4.2513E+10
85 At217	32.3 ms	7.4215E+07	2.6743E-14	4.3044E-02	4.4673E+08
83 Bi213	45.59 m	6.2836E+12	2.2224E-09	4.3034E-02	1.9924E+11
84 Po213	4.2 us	9.4463E+03	3.3410E-18	4.2134E-02	3.6433E+07
82 Pb209	3.25 h	2.6888E+13	9.3306E-09	4.3012E-02	0.0000E+00
83 Bi209 Stable	stable	7.1448E+15	2.4794E-06	0.0000E+00	0.0000E+00
81 Tl209	2.16 m	6.2249E+09	2.1602E-12	8.9940E-04	7.0022E+10
Total :		5.6379E+20	2.1442E-01	3.4858E-01	4.0788E+11

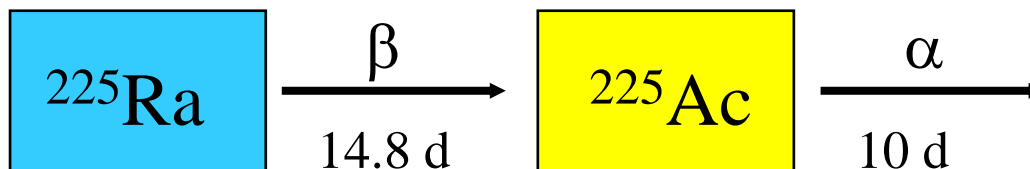


Build-up of Ra-225, Ac-225 from Th-229





2nd case: increase of Ac-225 as a Ra-225 daughter

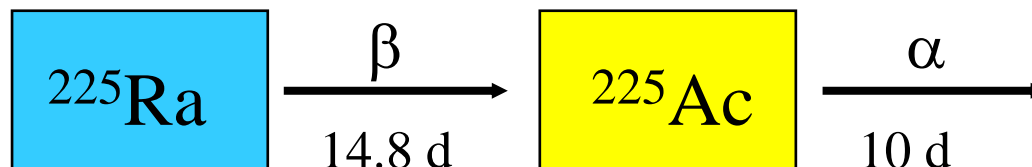


- ITU's Th-229 source: 45.6 mCi => every 9 weeks 43.2 mCi Ra-225

? Activity of Ac-225 14, 18 and 22 days after previous separation
? graphical plot until 22 days



2nd case: increase of Ac-225 as a Ra-225 daughter



- ITU's Th-229 source: 45.6 mCi => every 9 weeks 43.2 mCi Ra-225

? Activity of Ac-225 14, 18 and 22 days after previous separation

days	$A_{\text{Ra-225}}$	$A_{\text{Ac-225}}$
14	22.5 mCi	18.7 mCi
18	18.7 mCi	19.1 mCi
22	15.5 mCi	18.6 mCi



- choose the nuclide Ra-225 and open nuclides.net, decay-button
- enter the activity and time

nuclides.net **225 Ra** Full Decay

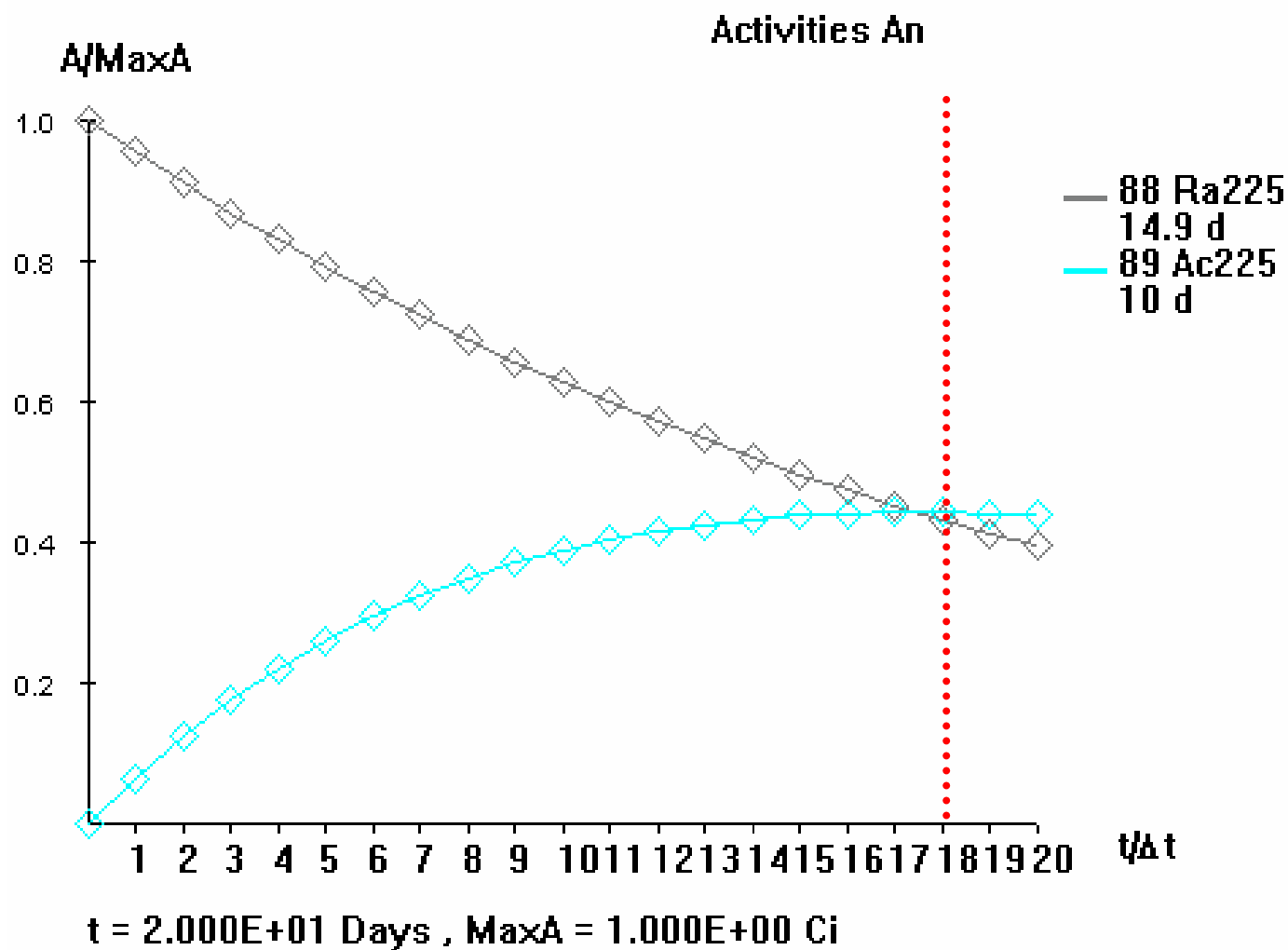
Options

Quantity: Curies 0.0432
Time: Days 18
Distance(cm): 100
Number of time steps: 18
Min. Prod.: 1E-02
N° Chains: 2
Start
Reset

Parent+Daughters	N(atoms)	M(g)	A(Si)	G(keV/s)	dH/dt(μSv/hr)
88 Ra225	1.2849E+15	4.8012E-07	1.8698E-02	8.3019E+09	3.7881E+01
89 Ac225	8.8253E+14	3.2977E-07	1.9135E-02	7.8734E+09	6.4016E+01
87 F223	3.0031E+11	1.1021E-10	1.8126E-02	1.8881E+10	9.1061E+00
85 At217	3.2960E+07	1.1877E-14	1.9116E-02	1.9840E+08	6.0272E-02
83 Bi213	2.7911E+12	9.8719E-10	1.9115E-02	8.8502E+10	1.8151E+01
84 Po213	4.1960E+03	1.4841E-18	1.8716E-02	1.6183E+07	2.4823E-03
82 Pb209	1.1951E+13	4.1474E-09	1.9118E-02	0.0000E+00	0.0000E+00
83 Bi209 Stable	7.8509E+14	2.7244E-07	0.0000E+00	0.0000E+00	0.0000E+00
81 Tl209	2.7651E+09	9.5958E-13	3.9951E-04	3.1104E+10	4.6988E+00
Total :	2.9676E+15	1.0876E-06	1.3343E-01	1.5488E+11	1.3392E+02



Ac-225 build-up from Ra-225 decay





3rd case:

Elution yields of Ac-225/Bi-213 generator



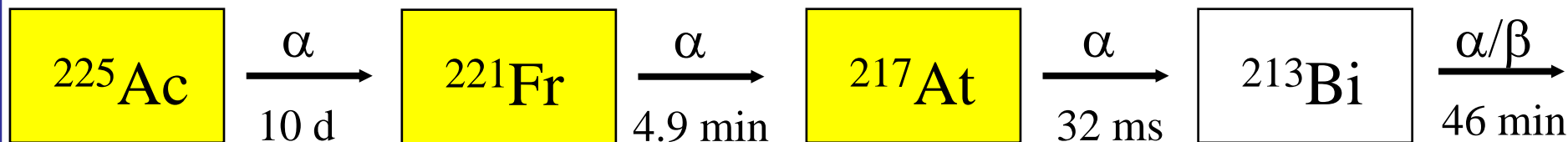
- 10 mCi Ac-225 Generator

? Activity of Bi-213 2, 3 and 4 hours after previous elution
? graphical plot until 4 hours



3rd case:

Elution yields of Ac-225/Bi-213 generator



- 10 mCi Ac-225 Generator

? Activity of Bi-213 2, 3 and 4 hours after previous elution

hour	$A_{\text{Ac-225}}$	$A_{\text{Bi-213}}$
2	9.9 mCi	8.2 mCi
3	9.9 mCi	9.2 mCi
4	9.9 mCi	9.6 mCi



- choose the nuclide Ac-225 and open nuclides.net, decay-button
- enter the activity and time

nuclides.net **225 Ac** Full Decay

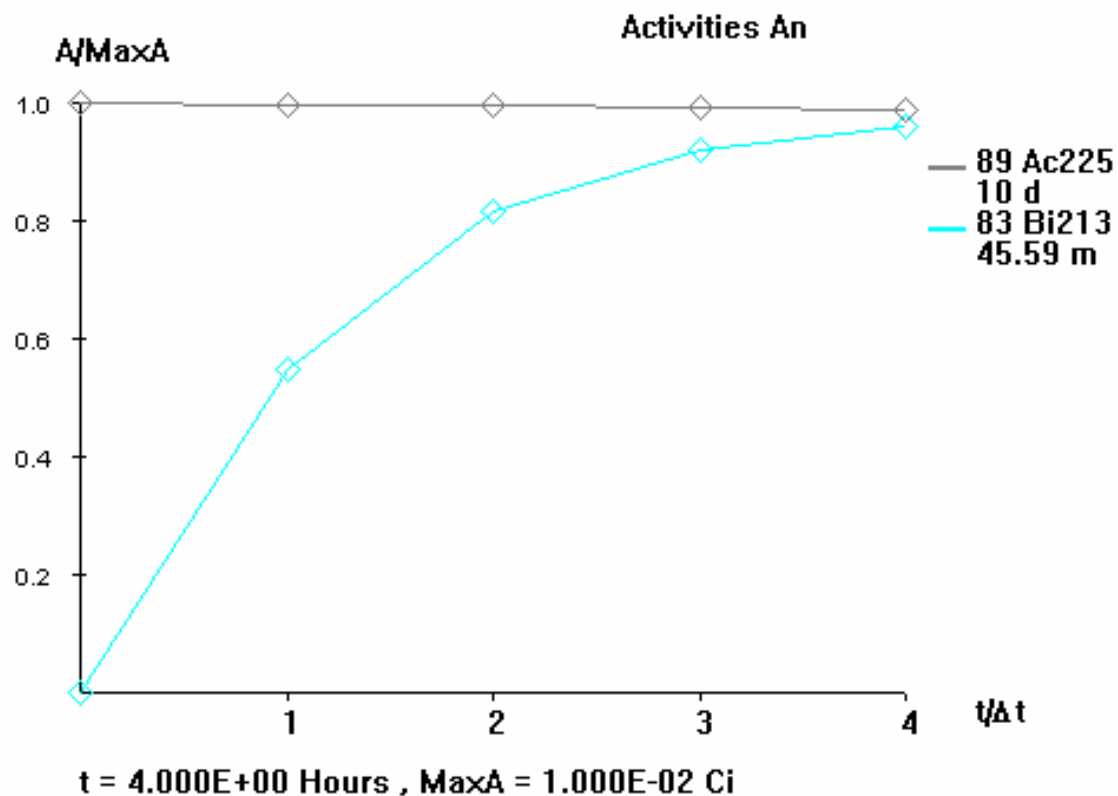
Options

Quantity:
Time:
Distance(cm):
Number of time steps:
Min. Prod.:
N° Chains:

Parent+Daughters	N(atoms)	M(g)	A(Bq)	G(keV/s)	dH/dt(μSv/hr)
89 Ac225	4.5590E+14	1.7035E-07	9.8850E-03	4.0672E+09	3.3069E+01
87 Fr221	1.5518E+11	5.6953E-11	9.8884E-03	9.7566E+09	4.7056E+00
85 At217	1.7032E+07	6.1374E-15	9.8785E-03	1.0252E+08	3.1146E-02
83 Bi213	1.4042E+12	4.9663E-10	9.6166E-03	4.4524E+10	9.1312E+00
84 Po213	2.1109E+03	7.4660E-19	9.4156E-03	8.1415E+06	1.2488E-03
82 Pb209	2.7215E+12	9.4443E-10	4.3536E-03	0.0000E+00	0.0000E+00
83 Bi209 Stable	1.0092E+12	3.5023E-10	0.0000E+00	0.0000E+00	0.0000E+00
81 Tl209	1.3892E+09	4.8208E-13	2.0071E-04	1.5626E+10	2.3606E+00
Total :	4.6119E+14	1.7220E-07	5.3238E-02	7.4084E+10	4.9299E+01



Bi-213 build-up from Ac-225 decay



Download File

Print Image



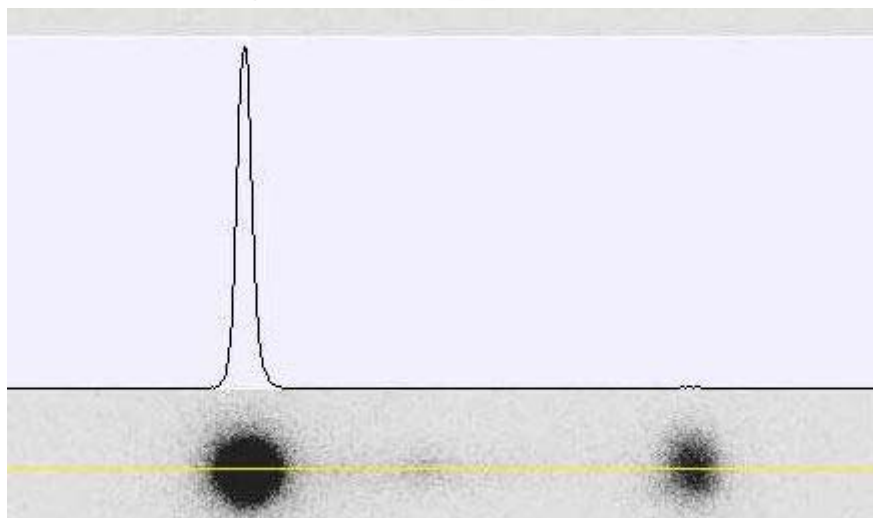
Labelling challenges

- fast, quantitative and reproducible labelling
 - mAb's at room temperature
 - peptides also higher reaction temperatures possible
- if required fast purification step (e.g. SE, HPLC)
- Quality control (ITLC, Radio-HPLC)

Labelling of Bi-213

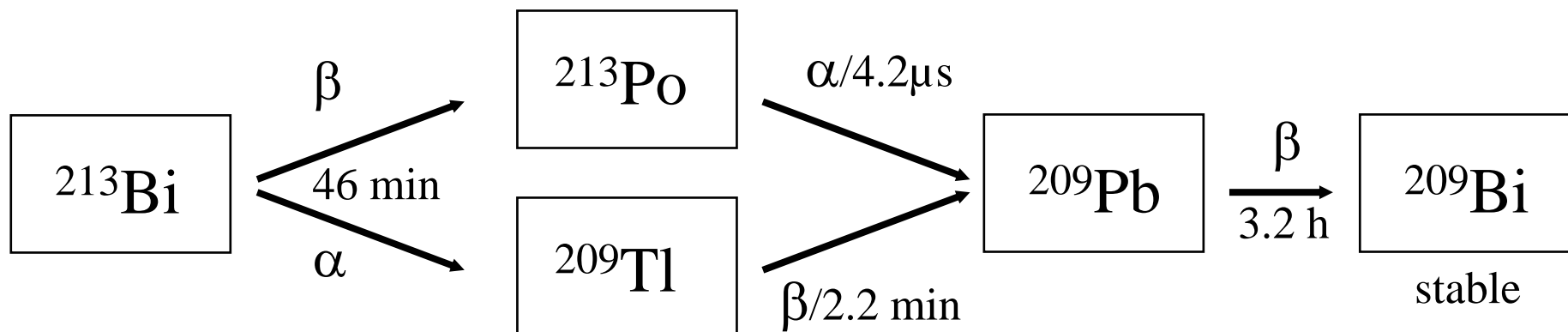
Proceeding:

1. Elution of Bi-213 with 0.1 M NaI / 0.1 M HCl into buffer (pH 5.5; approx. elution yield 85-90%)
2. Incubation with DTPA-chelated antibody (0.1-1 mg)
3. size exclusion chromatography (PD 10 column)
4. over all labelling time approx. 20 min, QC with ITLC





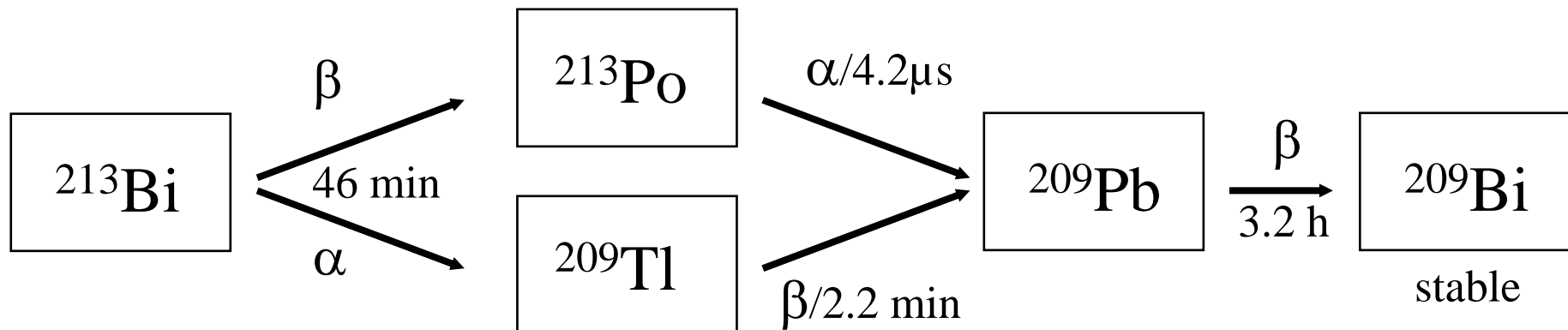
4th case: decay products of Bi-213



- mAb labelled with 5 mCi Bi-213

? decay products of Bi-213 4, 6 and 8 hours after labelling

4th case: decay products of Bi-213



- mAb labelled with 5 mCi Bi-213

? decay products of Bi-213 4, 6 and 8 hours after labelling

hours	$A_{\text{Bi-213}}$	$A_{\text{Po-213}}$	$A_{\text{Tl-209}}$	$A_{\text{Pb-209}}$
4	130 μCi	127 μCi	3 μCi	610 μCi
6	21 μCi	21 μCi	0.5 μCi	420 μCi
8	3 μCi	-	0.01 μCi	276 μCi



- choose the nuclide Bi-213 and open nuclides.net, decay-button
- enter the activity and time

nuclides.net **213 Bi** Full Decay

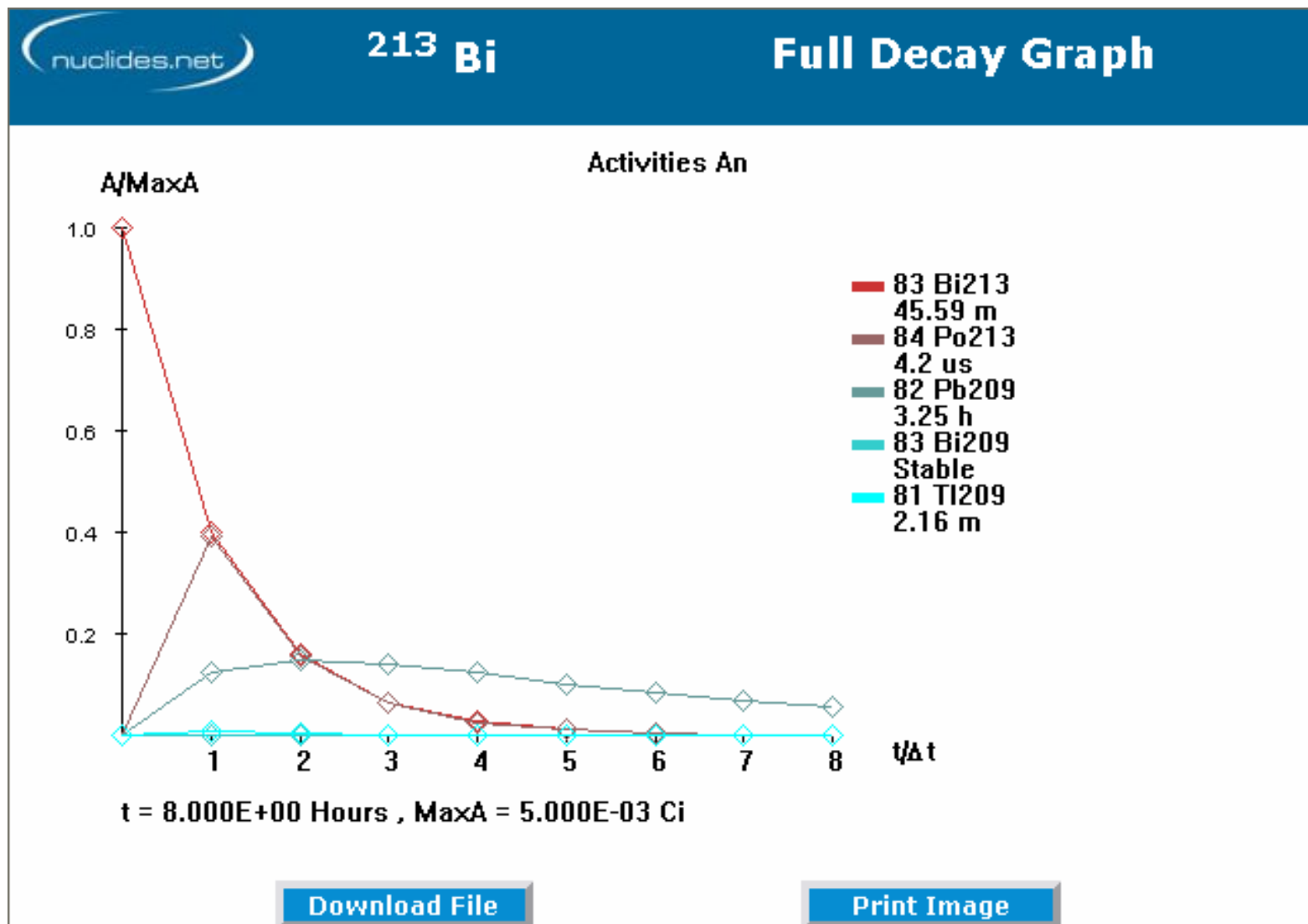
Options

Quantity:
Time:
Distance(cm):
Number of time steps:
Min. Prod.:
N° Chains:

Parent+Daughters	N(atoms)	M(g)	A(Ci)	G(keV/s)	dH/dt(μSv/hr)
83 Bi213	4.9422E+08	1.7480E-13	3.3848E-06	1.5671E+07	3.2139E-03
84 Po213	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00	0.0000E+00
82 Pb209	1.7261E+11	5.9898E-11	2.7612E-04	0.0000E+00	0.0000E+00
83 Bi209 Stable	5.5695E+11	1.9327E-10	0.0000E+00	0.0000E+00	0.0000E+00
81 Tl209	5.1398E+05	1.7837E-16	7.4261E-08	5.7816E+06	8.7340E-04
Total :	7.3005E+11	2.5335E-10	2.7612E-04	2.1453E+07	4.0873E-03



4th case: decay products of Bi-213





4th case: decay products of Bi-213

- Daughter nuclide Pb-209 ($t_{1/2}$ 3.2 h, β -emitter, 635 keV) will not be chelator bound
- 20 mCi of Bi-213 would decay to 1.01 ng of Pb-209

In comparison: WHO limits a maximum daily intake by ingestion of 430 μg , of which resorption in human body is about 10 %.



Thank you for your attention!